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The invention relates to a wheel for a piece of sports equipment, especially for grass skiing, comprising a rim and a tire that is fastened to the rim and is provided with a tread, and at least one support element for the tire, which support element is provided with a resilient configuration and extends in a curved manner from a first bearing section to a second bearing section.

There is an increasing need for novel sports equipment which allow a widening in the range of recreational activities. One type of sports equipment is such that allow a skiing-like downhill racing on snow-free slopes, which are thus used for so-called grass skiing. Such pieces of sports equipment are generally configured like skis, which means they are of a longish configuration with a binding for fastening to a shoe, but comprise at least two rollers instead of the running surfaces of skis.

Actual grass skiing is performed on meadows and thus requires a sufficiently smooth ground which is substantially free from obstructions. Within the terms of the present invention, however, the term "grass skiing" shall also be extended to activities in rougher terrain, i.e. skiing on graveled forest roads and other bases. The sports device, and especially the wheel of such a sports device within the terms of the invention, shall therefore offer a substantially all-terrain behavior, so that one is not forced to the use of meadows alone.

A further requirement placed on the sports device is that the control thereof can be learnt as simply as possible and the riding behavior is pleasant and the sequence of movement is as physiologically natural as possible in order to avoid injury to the locomotor system. A sequence of movements which is generally sensed as being very pleasant and fulfils the above requirements is the one obtained while skiing in deep snow. It is therefore desirable to create a sports device which in its riding behavior comes as close as possible to a ski which is driven in deep snow. It shall simulate in particular the behavior during turning and change of load in deep snow riding.

One import precondition for reaching the above riding behavior is a respective configuration of the wheels of the sports device. It must allow a certain maneuverability on the one hand and must ensure a respective steering behavior on the other hand in order to enable a change of direction, as in skiing.

A wheel is known from WO 00/27490 which can be used for inline skating. This wheel comes with an outside rim which is resiliently held relative to the inside rim in order to buffer shocks. A wheel is further known from 98/41295 which is also intended for inline skaters. In order to achieve a predetermined braking behavior when the skater moves transversally, a toroidal tire is provided which can turn about its own axis and thus allows a respective braked lateral movement of the wheel. Both prior known wheels as described above are not able to simulate the riding behavior of a ski in deep-snow skiing. In particular, the known apparatuses do not allow operation in rougher terrain.

The riding behavior can also not be adjusted according to the desired deep-snow riding behavior with wheels which are equipped in a conventional manner with pneumatic tires.

It is the object of the present invention to avoid such disadvantages and to create a wheel with which a riding behavior can be achieved which substantially corresponds to skiing in deep snow. A sequence of movements is to be especially promoted which is ergonomically useful and which does not have any detrimental effects on the skiers health but instead is therapeutically effective.

This is achieved in accordance with the invention that the support element extends in a curved manner from a first bearing section to a second bearing section and supports the tire essentially along the entire distance of the cross section thereof, and that the tire has a multi-layer structure and is provided with a layer that is elastic in the direction of thickness thereof.

The relevant aspect of the invention is the combination of support elements which provide a first larger part of the resilient behavior of the wheel, with an elastic layer in the direction of thickness, leading to a further part of the resilient effect. It has now been seen surprisingly that this combination of components

not only leads to a respective all-terrain mobility, but also leads to a riding behavior which is substantially similar to skiing in deep snow. This means a stable forward run is ensured up to a certain transversal force acting upon the wheel transversally to the riding direction. If said transversal force is exceeded, there will be a respective deformation of the tire in the region of the wheel tread, so that the wheel obtains a movement component transversally to the actual running direction. Since the threshold of the transversal force from which the transversal movement begins depends on the load of the wheel and since the magnitude of the movement component transversally to the running direction decreases with an increasing inclination of the wheel relative to vertical plane, a substantial similarity with deep-snow skiing is achieved.

According to an advantageous embodiment of the invention it is provided that the first and second bearing section are arranged on mutually opposite sides of the outer circumference of the rim. An especially sturdy configuration of the wheel is thus achieved.

An especially advantageous riding behavior can thus be achieved that a plurality of support elements are provided which are arranged spaced from one another in the circumferential direction. The deflection of the tire at a position (i.e. generally on the tread) can thus be substantially uncoupled from deformations at other places. This is in contrast to pneumatic tires in which the spring effect is caused by the inner overpressure. As a result of the pressure and the tensile stress in the tube or in the tire cover, the deformations depend on each other at least in adjacent regions, thus leading to a certain riding behavior which is certainly advantageous and beneficial for motorbikes for example. Skis can be simulated only insufficiently with this, however.

It is especially beneficial when the support elements are configured as metal leaf springs. The spring characteristic can be optimized according to different aspects in a direction transversally to the circumference of the wheel. It is alternatively also possible that the support elements are configured as meandering spring wires. Especially soft wires can thus be realized.

In a further preferred embodiment of the invention it is possible that additional spring elements are provided for supporting the support elements. Further degrees of freedom are thus achieved in the fine tuning of the wheel.

Special advantages are obtained in accordance with the invention in such a way that the tire is provided with a three-layer configuration and consists of a tread, a soft-elastic inner layer and a support layer. The support layer is mechanically robust in order to withstand the friction on the spring elements. The treads are provided with the profiling optimized for the respective terrain and have suitable resistance to wear. The soft-elastic inner layer is elastic in the direction of thickness and allows a fine spring behavior.

A specially advantageous embodiment of the invention provides an engagement element on the rim adjacent to the tire, which engagement element extends along the circumference of the rim. The engagement of the edges can thus be simulated, which engagement will become effective only from a certain angle of inclination in the transversal direction when skiing in deep snow.

A further improvement of the riding behavior can be achieved in such a way that the tire is provided with an unpressurized configuration. It is also especially advantageous when the outside diameter of the rim corresponds to approximately half the diameter of the wheel.

The invention further relates to a piece of sports equipment, especially for grass skiing, comprising a frame which extends in the longitudinal direction and on which at least two wheels are held with elastically deformable tires, a binding for fastening the sports device to a shoe of a person using the sports device, with a front wheel being arranged in front of the binding and a rear wheel being arranged behind the binding.

Such a sports device is characterized in accordance with the invention in such a way that an extension is provided on the frame behind the rear wheel, which extension comprises a support section at its end which can be brought by displacement of weight from one position above the floor to a position in which it touches the ground, and that at least one wheel is configured as described above.

Such a sports device allows for an especially advantageous riding behavior in connection with the wheel as described above. The riding behavior can be changed substantially through the extension by merely displacing the weight. In neutral load, the sports device stands with its wheels on the ground. The support section does not touch the ground however. The front wheel is relieved through a respective displacement of weight and the rear wheel is loaded more strongly. Since the wheels are provided with a respectively soft configuration, there is an inclination of the sports device to the rear by the altered deflection, so that that support section rests on the floor. Since the support section, in contrast to the wheels, virtually does not show any lateral guide force, the rotatability in this state is facilitated in a substantial way. This corresponds substantially to the riding behavior of skis in deep snow, which as a result of displacement of weight to the rear are respectively easier to turn.

Depending on the magnitude of the weight displacement, the front wheel remains relieved on the ground at first, but it can be made to lift off the ground by stronger displacement of weight.

In a preferred embodiment it is provided that the extension is resiliently fastened to the frame. A respectively soft transition in the riding behavior can thus be ensured. In addition or as an alternative thereto it can also be provided that the extension is elastic.

It is especially advantageous when the support section is provided with a plate-like configuration. The contact of the support section with the ground not only causes the effects as described above but also a certain amount of braking, which is not undesirable per se. The braking effect should be kept within certain margins so as not to cause any deviations from the desired behavior. The plate-like configuration of the support section is optimal in this respect.

An especially advantageous configuration of the sports device is achieved when the diameter of the wheels is between 20% and 50%, preferably approximately 30% of the axle base.

It is provided for in an especially advantageous embodiment of the invention that the binding is arranged directly in front of the rear wheel. The change of the riding behavior by displacement of weight is thus promoted.

The invention is now explained in closer detail by reference to embodiments shown in the drawings, wherein:

Fig. 1 shows a wheel in accordance with the invention in a first embodiment in a view;

Fig. 2 shows a sectional view along line II-II in Fig. 1;

Fig. 3, Fig. 4, Fig. 5 show different embodiments of the bearing of a support element in detail on an enlarged scale.

Fig. 6, Fig. 7, Fig. 8 and Fig. 8a show different embodiments of support elements, and

Fig. 9 schematically shows a sports device in accordance with the invention in a side view.

Wheel 1, which is shown in Fig. 1 and Fig. 2, principally consists of a rim 2 which is produced for example in aluminum or magnesium pressure die casting, and of a tire 3 fastened thereto. The rim 2 comprises a bore 4 for receiving a wheel axle (not shown) and the wheel bearing. The rim 2 comprises on its outer circumference on each of both sides a bearing section 5. Several support elements 6 extend outwardly in a curved manner between said bearing sections 5, which sections are configured as leaf springs made of metal. The support elements 6 are principally narrowly arranged over the circumference, but have a sufficient distance in order to allow a substantially independent deflection. In order to change the spring characteristic depending on the direction of the action of force, additional spring elements 7 can be provided as required which support the support elements 6 relative to the rim 2. The tire 3 rests freely on the support elements 6. In order to ensure that the seat is correct, fastening elements such as screws 8 are provided which fasten the tire 3 to the circumference of the rim 2.

The tire 3 is provided with a three-layer configuration and consists of an outer tread 9, a soft-elastic inside layer 10 and a support layer 11. The tread 9 is provided with an abrasion-proof configuration and is used for ensuring that the respective wheel grip is ensured. A profiling 12 which is shown schematically in Fig. 1 is provided for this purpose. The soft-elastic inside layer 10 is provided with a compressible configuration and consists of sponge rubber with a suitable stiffness for example or of cellular rubber. With approximately 30 mm, the thickness D_2 of the soft-elastic inner layer 10 in the unloaded state in the medial plane 2a is approximately fifteen times as large as the thickness D_1 of the tread 9. The soft-elastic inner layer 10 is so resilient that under nominal load it is compressed by approximately half, i.e. the thickness D_2 decreases to half the value. A load is assumed as nominal load which is obtained in the statistical case when the sports device is loaded with a user of average weight.

The support layer 11 is used primarily to ensure the respective mechanical strength at the connection point to the support elements 6. As is shown in Fig. 2, the thickness of the inner layer 10 is largest medially and decreases continually in the lateral direction. The riding behavior can be influenced and adjusted accordingly by a respective choice of the dimensions. Annular hard rubber edges 13 are attached to the rim 2 laterally adjacent to the base region of tire 3, which edges come into engagement with the ground from a certain inclination of the wheel 1. They can thus simulate the use of edges of an alpine ski because a lateral movement is substantially prevented.

Fig. 3 shows a first embodiment of the fastening of the support elements 6 on the rim 2 in detail. The support element 6 of Fig. 3 is displaceably held in the longitudinal direction in a slot 14 which is arranged in the bearing section 5. In order to enable a respective deflection of the support element 6, the slot 14 is conically outwardly extended in its end section. A spring 15 controls the movement of the support element 6 in the direction of the slot 14.

The support element 6 is rigidly clamped in the rim 2 in the embodiment of Fig. 4. A substantially higher stiffness is achieved in this embodiment in the region of rim 2.

In the embodiment of Fig. 5, the support element 6 is clamped in a bearing body 16 which on its part is rotatably held in the rim 2. An especially soft spring behavior can be achieved in this embodiment in the ambience of rim 2.

Fig. 6, Fig. 7 and Fig. 8 show different embodiments of the support element 6 in an unwound shape. In the embodiment of Fig. 6, the support element 6 is enlarged in the middle section, so that the individual support elements 6 have approximately the same distances in the assembled state.

The support element 6 of Fig. 7 has a similar configuration as the one of Fig. 6, with the exception that in the middle region a tapering section 17 is provided. A special spring characteristic can thus be achieved in the medial region. A further embodiment of the support element 6 is shown in Fig. 8, which shows a support element 6 which is configured as a meandering spring wire. An especially soft spring behavior thus generally be achieved. Fig. 8a shows a modification of the meandering embodiment of Fig. 8, in which the meanders are partly arranged in the circumferential direction and partly transversally thereto.

The wheel 1 in accordance with the invention generally comprises a diameter of between approx. 23 cm and 28 cm and comes with a cramped structure as a result of its relatively large width of approximately 15 cm. Since the tire 3 has a non-pressurized configuration, which means that even in the unloaded state it has no inner overpressure, the deformation behavior of individual sections of the tire 3 is substantially independent of the current deformation state of other sections. Special attention is given to the fact that the deformation resistance can be set within wide margins depending on the location and the angle of the introduction of the force depending on the configuration of the support elements 6 and their anchoring on rim 2, so that an optimal adjustment can be achieved.

Fig. 9 shows a sports device in accordance with the invention in a side view in an unloaded state. The sports device consists of a frame 20 to which a front wheel 1a and a rear wheel 1b are attached. A schematically indicated shoe 22 for the user of the sports device can be fastened via a binding 21. The front wheel 1a is rigidly fastened via a front fork 22 to a front part 23 of the frame 20 which is drawn over the front wheel 1a. The rear wheel 1b is also rigidly held on a fork 24

of the frame 20. A single-arm bearing can also be provided instead of the fork in the actual sense, which bearing holds the wheel 1a, 1b on only one side with a floating axial stub.

At the rear end of the fork 24 there is an extension 25 which carries a support section 26 at its end. The sports device is made of light metal in order to achieve the lowest possible weight with the required strength and stiffness.

In an evenly loaded sports device, i.e. when the center of gravity of the person using the sports device is substantially above the shoe 22, the extension 26 is arranged at a distance x above the floor surface 27, with x being 10 mm for example. The deformation of the wheels 1a, 1b by a path z or y as is only indicated in Fig. 9 is then $z = 16$ for example for the front wheel 1a and $z = 20$ mm for the rear wheel 1b. By displacement of the weight to the rear it is possible to achieve a respective deformation of the tires 3 of the wheels 1a, 1b, so that the sports device inclines in one direction in a counter-clockwise manner and the support section 26 touches the ground 27. The contact of the support section 26 occurs when the front wheel 1a is relieved to $z = 10$ mm by weight displacement and the rear wheel is additionally loaded to $y = 26$ mm. Since the front wheel 1a is still partly loaded, a lateral guide force can still be accepted. It is further reduced by a further relief of the front wheel 1a, with such reduction occurring continuously and not abrupt, as would be the case when the front wheel 1a would lift off immediately. A minimum deformation of 15 mm at nominal load has proved to be the lower limit for an optimal operation of the sports device.

The extension 25 is provided with a resilient configuration, so that a stronger inclination can be obtained in a further displacement of weight to the rear, which inclination can finally lead to the consequence that the front wheel 1a will lift off from the ground 27. As a result of the lower lateral guide force of the extension 26, the steerability is thus increased substantially. In the embodiment of Fig. 9, the support section 26 is provided with a plate-like configuration. For riding on asphalt it is also possible to provide a roller at this place in order to reduce the development of noise and the resistance.

In the illustrated embodiment, the diameter D of the wheels 1a, 1b is approximately 40% of the axle base L . Depending on the respective embodiment, the diameter D of the wheels 1a, 1b must be chosen between 20% and 50% of the axle base L . Fig. 9 further shows that the binding 21 is arranged in such a way that the shoe 22 ends directly before the rear wheel 1b.

The distance A of the support section 26 of the axle 29 of the rear wheel 1b is approx. 50% of the axle base L measured horizontally, i.e. the distance of the axles 28 and 29. A range of between 30% and 60% is advantageous.

The present invention allows achieving a riding behavior which is substantially similar to that of skis in deep snow. In particular, similar trick ski figures can be performed.